

THE BIDIRECTIONAL REFLECTANCE SPECTRA OF FIVE GAS-RICH ORDINARY CHONDRITES.
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Introduction: A major objective in asteroid science is the identification of the main asteroid belt parent bodies of ordinary chondrite meteorites. Ordinary chondrites account for 80% of observed meteorite falls, but so far no main belt parent bodies have been unequivocally identified for this meteorite type. Part of the answer to this puzzle may lie in the spectral characteristics of the ordinary chondrite parent body regoliths. The spectra of gas-rich ordinary chondrites can provide clues to reconstructing the spectra of an ordinary chondrite regolith. Gas-rich ordinary chondrites are generally characterized by a light/dark structure of light clasts, chondrules, and fragments of chondrules set in a dark, fine-grained matrix containing grains rich in solar wind implanted gases [1,2]. The dark matrix grains contain not only solar wind gases, but also dense assemblages of solar flare tracks indicating that these grains were exposed on the surface of the parent body and probably represent samples of relithified regolith soil [3,4]. If this material is regolith soil, its spectral characteristics would help clarify the spectral effects of regolith processes and provide insight into the spectra of ordinary chondrite parent bodies.

The Distribution of Light and Dark Material: While the optical characteristics of gas-rich chondrites are dominated visibly by their light/dark structure, the distribution of light and dark material makes it difficult to obtain the spectra of relatively "pure" dark material. This is due to the intimate mix of light clasts, chondrules, and fragments, and dark grains in the matrix. Although the dark matrix is fine grained, the light material is apparent in all particle sizes down to fractions as fine as the dark grains within the matrix. The light material occupies a significant fraction of the "dark" matrix area. Point counts using thin sections of Dwaleni (H6) and Leighton (H5) show that the light material accounts for approximately 67% and 49% respectively of the aerial coverage in the "dark" matrix area. Clearly, any spectrum of material from a dark area will include a significant component of light clast material.

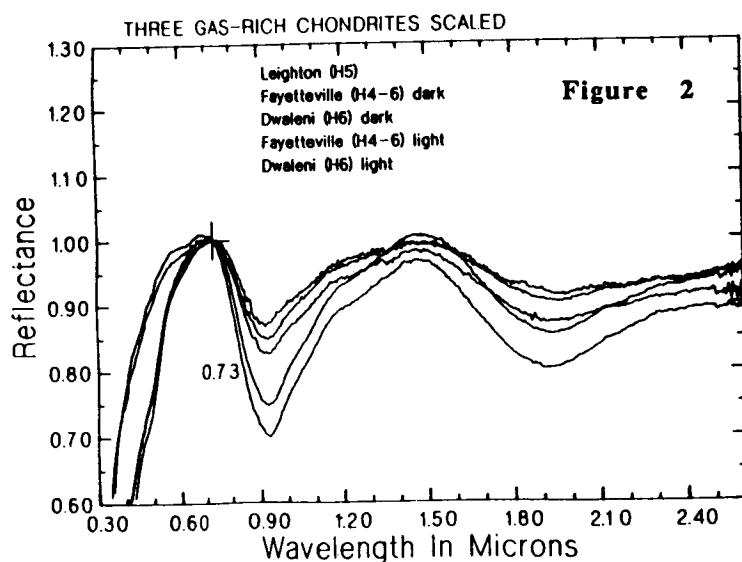
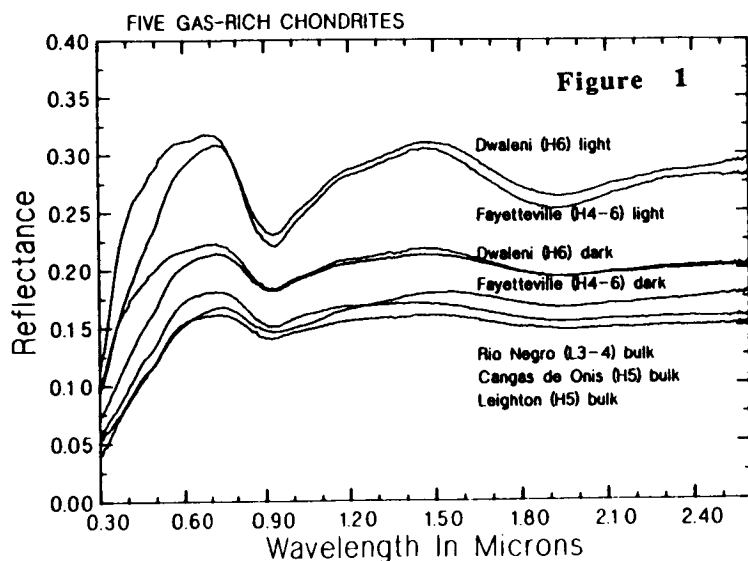
The Spectra of Gas-Rich Ordinary Chondrites: Shown in Figure 1 are the spectra of five gas-rich ordinary chondrites. The samples of Dwaleni (H6) and Fayetteville (H4-6) have relatively definite light and dark areas and the spectra of separates from these areas are shown, although it should be emphasized that the dark areas of these meteorites still have a significant fraction of light material. The spectrum of the dark area is by no means a spectrum of "pure" dark matrix.. The samples Leighton (H5), Cangas de Onis (H5) and Rio Negro (L3-4) were too intimately mixed to separate light and dark fractions and as a result, the spectra of crushed bulk samples are shown. In all cases bidirectional reflectance spectra were obtained of crushed powders at a viewing geometry of $i=30^\circ$, $e=0^\circ$, using the RELAB spectral facility.

The light fractions of both Dwaleni and Fayetteville are very bright with visible reflectances of 0.32 and 0.27 respectively. The light area spectra also show very strong, high contrast absorption bands that are excellent examples of normal ordinary chondrite spectra [5]. The dark portions of these meteorites exhibit evidence of alteration of their optical properties. In both samples the reflectance and band depth has been significantly diminished. For Dwaleni reflectance at $0.55 \mu\text{m}$ decreases from 0.32 to 0.22, a drop of over 30%. Although some reduction in apparent band depth would be expected due to the decreased reflectance, in this case the reduction is substantially out of proportion to the drop in reflectance. Shown in Figure 2 are the spectra of Dwaleni, Fayetteville and Leighton scaled to unity at $0.73 \mu\text{m}$. The depth of the $1.0 \mu\text{m}$ band is approximately 30% for the light portion of Dwaleni, while the corresponding dark material shows a band depth of 17%, a reduction of 43%. The $2.0 \mu\text{m}$ band is similarly reduced by approximately 35%. For Fayetteville the band reductions are 40% for the $1.0 \mu\text{m}$ band and 46% for the $2.0 \mu\text{m}$ band. Another feature of these spectra is the change in overall spectral slope. In the light portions of both Dwaleni and Fayetteville the spectra are slightly blue sloped, decreasing in reflectance about 11% and 9% respectively between $0.73 \mu\text{m}$ and $2.6 \mu\text{m}$. This blue slope has been reduced in the dark fractions to about 5% for both samples, a reduction of 55% and 45% respectively. This suggests that the darkening agent in the matrix not only reduces the reflectance and suppresses the absorption features, but also has a modest red slope. It should be

emphasized that these reductions in reflectance and band depth occur despite significant proportions of light material in the dark areas. The spectra of these areas are not spectra of pure dark matrix but a complex mix of clasts from the light material along with the dark gas-rich grains.

The spectra of bulk samples of Leighton, Rio Negro, and Cargas de Onis also show substantial reductions in reflectance and band depth relative to normal ordinary chondrites. As shown in Figure 2 Leighton has a $1.0\ \mu\text{m}$ band depth of 12% while the range for normal ordinary chondrites is approximately 20-30%. Once again, these samples are a mix of light and dark material and the spectrum of pure dark material would be substantially darker.

Conclusions: In general, the spectra of the dark areas of gas-rich ordinary chondrites show reductions in both reflectance and band depth relative to the spectra of the light areas and the spectra of normal ordinary chondrites. The dark areas of these samples show spectral alteration despite having substantial fractions of light material intimately mixed with the dark, gas-rich grains. If the spectra of the dark gas-rich grains represent the spectral characteristics of a regolith soil on an ordinary chondrite parent body, then that surface would display a dark and strongly subdued spectrum.



Acknowledgements: The authors wish to express thanks to C.A. Francis of the Harvard University Mineralogical Museum, G.J. MacPherson of the Smithsonian Institution, R. Hutchison and V. Jones of the British Museum (Natural History), and D. Sears of the University of Arkansas for generously granting access to their respective collections and for the loan of meteorite samples. This research was supported by NASA grant NAGW-28 and by a NASA Graduate Student Research Fellowship to D.T. Britt. RELAB is supported as a NASA-multiuser facility under grant NAGW-748.

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